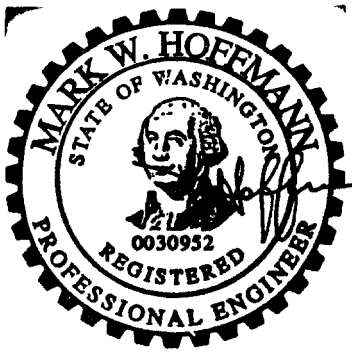
ISSUED BY RPP-WTP PDC
INIT DATE 3/19/04

RIVER PROTECTION PROJECT – WASTE TREATMENT PLANT

ENGINEERING SPECIFICATION

FOR

Shell and Tube Heat Exchanger



This bound document contains a total of 11 pages.

Content applicable to ALARA? ☒ Yes ☐ No

ADR No. N/A

Rev

Quality Designator
QL
DOE Contract No. DE-AC27-01RV14136

NOTE: Contents of this document are Dangerous Waste Permit affecting.

REV	DATE	REASON FOR REVISION	BY	CHECK	REVIEW	QA	APEM/DEM
1	3/19/04	Issued for Permitting Use				N/A	
0	10/2/02	Issued for Permitting Use	Jessica Jackson	Richard Polmanteer	Suzanne Kirk	N/A	N/A

SPECIFICATION No. 24590-WTP-3PS-MES0-TP001 **Rev** 1

Please note that source, special nuclear and byproduct materials, as defined in the Atomic Energy Act of 1954 (AEA), are regulated at the U.S. Department of Energy (DOE) facilities exclusively by DOE acting pursuant to its AEA authority. DOE asserts, that pursuant to the AEA, it has sole and exclusive responsibility and authority to regulate source, special nuclear, and byproduct materials at DOE-owned nuclear facilities. Information contained herein on radionuclides is provided for process description purposes only.

Contents

1 Scope 3
2 Applicable Documents 3
2.1 General 3
2.2 Codes 3
2.3 Industry Standards 3
2.4 Reference Documents/Drawings 3
2.5 References 4
3 Design Requirements 4
3.1 Basic Requirements 4
3.2 Supplemental Quality Level Criteria for Heat Exchangers 4
3.3 Tubes and Tube Bundles 5
3.4 Tubesheets 6
3.5 Impingement Plates, Baffles and Seals 6
3.6 Channels 7
3.7 Shell, Shell Covers and Shell Supports 7
3.8 Flanged External Girth Joints 8
3.9 Expansion Joints 8
4 Supplemental Testing Requirements 8
5 Quality Assurance 9
5.1 General Requirements 9
5.2 Quality (Q) Related Components 9

Appendices

Appendix A Revision History ..... A-i

1 Scope

This specification supplements the RPP-WTP Specification for Pressure Vessel Design and Fabrication (24590-WTP-3PS-MV00-TP001). This specification, together with the purchase order, data sheets, and drawings, covers the requirements for the design, fabrication, and testing of shell and tube heat exchangers for the River Protection Project – Waste Treatment Plant (RPP-WTP) located at Hanford in the southeastern part of Washington State.

2 Applicable Documents

2.1 General

2.1.1 Work shall be done in accordance with the referenced codes, standards, and documents listed below, which are an integral part of this specification.

2.1.2 When specific chapters, sections, parts, or paragraphs are listed following a code, industry standard, or reference document, only those chapters, sections, parts, or paragraphs of the document are applicable and shall be applied. If a date or revision is not listed, the latest issue, including addenda, at the time of Request for Quote (RFQ) shall apply. When more than one code, standard, or referenced document covers the same topic, the requirements for all must be met with the most stringent governing.

2.2 Codes

2.2.1 American Society of Mechanical Engineers, Boiler and Pressure Vessel Code, Section VIII, Division I, Rules for Construction of Pressure Vessels(Applicable to QL1 and QL2 category components only)

2.2.1 American Society of Mechanical Engineers, Quality Assurance Requirements for Nuclear Facilities, ASME NQA-1 (1989)

2.3 Industry Standards

Standards of the Tubular Exchanger Manufacturers Association (TEMA Standard) – Eighth Edition - 1999

2.4 Reference Documents/Drawings

2.4.1 RPP-WTP Specification for Pressure Vessel Design and Fabrication, 24590-WTP-3PS-MV00-TP001

2.4.2 RPP-WTP Specification for Supplier Quality Assurance Program Requirements, 24590-WTP-3PS-G000-T0001

2.5 References

Zick, L. P., "Stresses in Large Horizontal Cylindrical Pressure Vessels on Two Saddle Supports", page 959, Pressure Vessels and Piping: Design and Analysis, A Decade of Progress, Volume II, published by ASME.

3 Design Requirements

3.1 Basic Requirements

3.1.1 Unless otherwise specified, all shell and tube heat exchangers shall be designed and fabricated in accordance with the ASME Section VIII Division 1, the TEMA standard, the RPP-WTP Specification for Pressure Vessel Design and Fabrication, and any additional requirements of this specification and the referenced drawings.

3.1.2 The Buyer's thermal design requirements will be shown on the individual Mechanical Data Sheet (MDS). When the Buyer's MDS or Mechanical Drawing show the mechanical sizes (diameters, length, tube number, sizes, etc.), this data shall be considered as preliminary. Seller shall verify the thermal, hydraulic and mechanical designs. Where necessary, the Seller shall change the exchanger size in order to furnish complete thermal, hydraulic and mechanical guarantees. Seller shall calculate the heat transfer rate for each unit and base the design on the minimum surface necessary to guarantee that the heat exchanger offered is satisfactory for the duty and fouling factors specified. Buyer's preliminary area estimate, where specified and determined to be conservative, shall prevail.

3.1.3 If ASME Section VIII, Division 1 specifies two allowable stresses for the design of pressure parts, the lower value must be used for the design of tubesheets, bolted flanges, and flat cover plates.

3.1.4 The steam condensing side of any heat exchanger shall be designed for full vacuum. In addition, any chamber subjected to partial vacuum in any service shall be designed for full vacuum unless otherwise noted or approved by the Buyer.

3.1.5 When stacked exchangers are specified by Buyer, Seller shall be responsible for investigating and solving any thermal-expansion related problems for the interconnecting nozzles and supports.

3.1.6 Floating head construction shall not be used unless otherwise noted on the MDS or approved by the Buyer. A "packed gland" type is not acceptable.

3.2 Supplemental Quality Level Criteria for Heat Exchangers

3.2.1 Heat exchanger quality level shall be specified on the MDS by the buyer.

3.2.2 Quality Level 1 heat exchangers shall be TEMA Class B and shall be of all welded construction. Tubes shall be welded to the tubesheet(s) with full strength welds. The tubes shall include a corrosion allowance, shown on the mechanical drawing, for the process side of the tube walls.

3.2.3 Quality Level 2 heat exchangers shall be TEMA Class B and shall be of all welded construction on the process fluid side. Tubes shall be welded to the tubesheet(s) with full strength welds.

3.2.4 Commercial Quality heat exchangers shall be TEMA Class C or B with no restriction on body flanges. For heat exchangers in cyclic services, tubes shall be welded to the tubesheet(s) with strength welds.

3.3 Tubes and Tube Bundles

3.3.1 Tubing shall be seamless unless otherwise noted or approved by Buyer. Tube-to-tube welds/joints are not permitted.

3.3.2 When tube outside diameter and thickness are shown on the mechanical drawing, they are for the straight tube section of the tube bundle.

3.3.3 Straight tube length shall be a maximum of 20 feet, unless otherwise noted or approved by Buyer.

3.3.4 All austenitic stainless steel U-tubes shall be solution annealed after bending, unless otherwise noted or approved by Buyer.

3.3.5 If strength welded tube-to-tubesheet welds are not used, Seller shall verify that the yield strength of the tube material does not exceed the yield strength of the tubesheet material. This is to ensure quality rolling, expansion and sealing of tubes to tubesheet.

3.3.6 Tube bundles shall be designed, in accordance with the TEMA standard, to prevent tube damage that may be caused by flow induced or acoustic vibrations.

3.3.7 Weighted mean temperature difference (MTD) shall be used only when the Seller provides heat release curves or tables.

3.3.8 When calculating the effective surface area of the heat exchanger, the tube length within the thickness of the tubesheet shall be excluded.

3.3.9 For U-tube bundles with full diameter support adjacent to the bends, the surface area of the return bends shall not be included in the heat transfer calculations.

3.3.10 The number of tubes in any pass shall be within 10 percent of the average number of tubes per pass.

3.3.11 For heat exchangers in non-radioactive service, with a tube bundle diameter 30 inches or larger, skid bars shall be provided to facilitate bundle removal.

3.3.12 The maximum bundle diameter shall be 60 inches unless otherwise noted on the MDS or approved by the Buyer.

3.4 Tubesheets

3.4.1 Tubesheet thickness calculations shall be in accordance with TEMA and be based on both the corroded and uncorroded states.

3.4.2 When tube material is austenitic stainless steel, special close-fit tube holes per TEMA shall be used.

3.4.3 Unless otherwise specified by the Buyer, the design temperature for tubesheets shall be taken as the larger of either the shell-side or tube-side design temperatures specified on the MDS.

3.4.4 Four tapped holes for bundle pulling shall be equally spaced in the face of all removable bundle tubesheets. Plugs of the same material as the tubesheet shall be provided for plugging the holes.

3.4.5 When a bonnet-type head is used as the stationary end of a U-tube heat exchanger, the diameter of the fixed tubesheet shall be equal to the outside diameter of the shell flange. The tubesheet shall be counterbored to accept collar studs. Approximately 25%, with a minimum of four, of the flange studs shall be collar studs. They are to be provided with lock nuts on the shell-side of the flange. Tapped tubesheet bolt holes in lieu of collar studs are not allowed without prior Buyer approval.

3.4.6 When hub-type fixed tubesheets are required, the hub shall be integrally forged with the tubesheet. Hubs made from built-up weld metal shall not be permitted.

3.4.7 For multiple pass exchangers, the design of the exchanger shall take into account the effect of gasket seating at the pass partitions. Tube openings shall not be obscured by partition plates or gaskets.

3.5 Impingement Plates, Baffles and Seals

3.5.1 Single pass tube-side design with axial nozzles shall use conical heads or shall have a full diameter perforated plate in the inlet channel, which provides both impingement protection and even flow distribution.

3.5.2 For plate-type impingement devices, plates shall be circular solid plates that are securely fastened or welded to the spacer tubes or tie rods. The plate shall be located a minimum distance of 0.25 times the nozzle inside diameter downstream of the nozzle.

3.5.3 For rod-type impingement devices, the design shall include a minimum of two rows of rods on a triangular pitch. The rod diameter may be smaller than the tube diameter but there shall be an overlap of approximately 0.125 inch between rows.

The top of the first row of rods must be located a minimum distance of 0.15 times the nozzle inside diameter downstream of the nozzle.

3.5.4 Shell-side baffles, support plates and partition plates shall be provided with minimum 3/8 inch notches to drain the heat exchanger.

3.5.5 For the transverse baffles in horizontal heat exchangers, horizontal baffle cuts shall be utilized for single phase and vaporizing shell-side services while vertical baffle cuts shall be utilized for "high solids content" fluids and condensing shell-side services.

3.5.6 Dummy tubes or solid bars shall be placed in the shell-side void areas caused by pass partition plates. These devices are not required for isothermal shell-side vaporization or condensation, or when the baffle cut is parallel (or within 45° of parallel) to the pass partition plate.

3.5.7 Bypass seal devices are required when the radial clearance between the outer tube limit (OTL) and the shell is greater than one tube diameter. The bypass seals shall be placed 1 to 3 inches from the baffle cut and approximately every six rows of tubes, and shall extend to within the ligament distance of the tubes. These sealing devices are not required for isothermal shell-side vaporization or condensation.

3.6 Channels

3.6.1 For flat channel covers, the maximum allowable deflection shall be 0.03125 inch.

3.6.2 Flat covers welded to the channel are not permitted.

3.7 Shell, Shell Covers and Shell Supports

3.7.1 Unless otherwise required by the design conditions, the minimum shell thickness, exclusive of corrosion allowance, shall be the greater of ¼ inch or TEMA minimums.

3.7.2 The minimum permissible shell cover thickness specified in TEMA shall be treated as after forming, and shall not be less than ¼ inch nominal.

3.7.3 Shell covers shall not be constructed of flat cover plates welded to the shell.

3.7.4 Shell supports shall be designed to withstand all superimposed loads plus fifteen percent margin. For stacked shells with shell diameter above 40 inches, full wrapper plates shall be considered on the lower shell. Horizontal exchanger supports shall be designed per the L. P. Zick method or approved equal.

3.7.5 Heat exchanger shell shall be checked to ensure bundle installation without binding (grinding of baffles to permit insertion/reinsertion is not acceptable). For horizontal heat exchangers, bundles shall be withdrawn, after insertion, a distance equal to the lesser of two central baffle spaces or 4 feet, then reinserted.

3.8 Flanged External Girth Joints

3.8.1 Unless otherwise noted or approved by the Buyer, body flanges shall be welding neck.

3.8.2 All end flanges shall be checked for axial alignment and gasket face flatness after welding to the shell and stress relieving. Final gasket surface machining shall be done after welding and stress relieving.

3.8.3 For flange bolting where the bolt diameters are 1-1/4 inch or greater, bolt length shall be increased in length by one bolt diameter to permit use of bolt tensioners. Flange dimensions must allow the use of the tensioner.

3.8.4 All gasket inside diameters shall be greater than the corroded inside diameter of the component it will seal.

3.9 Expansion Joints

3.9.1 It is the Seller's responsibility to determine the need for shell expansion for the conditions specified by the Buyer using TEMA rules. When determining the need for an expansion joint in fixed tubesheet heat exchangers, the most stringent of the following shall be considered:

- Normal operating conditions.
- Shell-side start-up; no fluid tube-side.
- Tube-side start-up; no fluid shell-side, shell at most severe ambient temperature.
- Loss of cold fluid on either shell side or tube side.
- Specified turndown operating conditions.
- Hydrotest
- Steamout or other cleaning procedures, when specified.

All conditions and the frequency (based on data supplied by the Buyer) shall be considered by the Seller. The Seller shall recommend the necessity of an expansion joint to achieve the required equipment service life as stated on the MDS.

3.9.2 If an expansion joint is required, shell expansion joint shall be the flanged and flued type.

3.9.3 Flanged and flued expansion joint shall be the same material, with at least the same thickness, as the shell (including corrosion allowance). Minimum thickness shall satisfy both TEMA and ASME Section VIII, Division 1 requirements.

4 Supplemental Testing Requirements

Leak Testing - Where tube to tubesheet welding has been performed, the welds shall be subjected to a 15 psig air and soap bubble test before the hydrostatic test.

5 Quality Assurance

5.1 General Requirements

5.1.1 The Seller's Quality Assurance Program (QAP) Requirements are included in 24590-WTP-3PS-G000-T0001, Supplier Quality Assurance Program.

5.1.2 Seller's QAP Manual shall be submitted to buyer for review in accordance with 24590-WTP-3PS-G000-T0001, Supplier Quality Assurance Program.

5.1.3 Seller's QAP, as a minimum, shall contain the requirements detailed in the Supplier Quality Assurance Program Requirements Data Sheets listed in Section 2 of the MR.

5.2 Quality (Q) Related Components

5.2.1 Seller shall have in place a QA program meeting the requirements of ASME-NQA-1-1989, marked as applicable in Supplier Quality Assurance Program Requirements Data Sheet attached to the MR, and Buyer specification 24590-WTP-3PS-G000-T0001.

5.2.2 Deleted

5.2.3 All items shall be manufactured in accordance with the Seller's Quality Assurance Program that meets the requirements of ASME NQA-1-1989, and has been previously evaluated and accepted by the RPP-WTP Quality Organization.

5.2.4 Seller shall submit their QA program and work plan to Buyer for review prior to commencement of work. The plan shall include documents and procedures to implement the work and include a matrix of essential Quality Assurance elements 7cross referenced with the documents/procedures.

Appendix A
Revision History

Rev. 0 -Issue specification for procurement, advance revision level from Revision B to Revision 0. Changes made in specification wording are highlighted with Revision bars.

Rev. 1 -Issued for Permitting Use.